IEC 61340-4-9

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Electrostatics –
Part 4-9: Standard test methods for specific applications – Garments

Électrostatique –
Partie 4-9: Méthodes d'essai normalisées pour des applications spécifiques – Vêtements

IEC 61340-4-9:2016-04(en-fr)

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CONTENTS

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ELECTROSTATICS –

Part 4-9: Standard test methods for specific applications – Garments

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International Standard IEC 61340-4-9 has been prepared by IEC technical committee 101: Electrostatics.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) classification of three types of garments
   - static control garments,
   - groundable static control garments, and
   - groundable static control garment system;

b) additional measurements according to the the garment type including cuff measurements, panel to groundable point, testing with a person in the garment system;

c) sleeve to sleeve measurements allowed with probes or by hanging;

d) additional recommended values for new garment types as set out in Annex A.

The text of this standard is based on the following documents:

FDIS	Report on voting
101/500/FDIS	101/502/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61340 series, published under the general title *Electrostatics*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This part of IEC 61340 provides test methods for evaluating the electrical resistance of garments that contain surface conductive or dissipative components or materials used in the electronics industry for the control of electrostatic discharge. This standard defines procedures for measuring electrical resistance, including a system resistance test for garments that provide a ground path for personnel.

Clothing made from synthetic fibres is a common source of electrostatic charge. Wearing an appropriate static control garment over personal clothing can minimize the effect of this charge. To effectively control electrostatic charges, the static control garment should be grounded.

Three categories of garments are considered in this standard.

a) A static control garment may suppress or otherwise affect an electric field from clothing worn underneath the garment without being attached to ground. However, without grounding, a charge may accumulate on conductive or dissipative elements of a garment, if present, resulting in a charged source.

b) A groundable static control garment may provide a higher level of suppression when the lower resistance fabric is connected to ground.

c) A groundable static control garment system provides a ground path for a person that suppresses the electrical field from clothing worn underneath the garment and also bonds the skin of the wearer to an identified ground path. Groundable static control garment systems may also be used in conjunction with a continuous or constant monitoring system in a manner similar to those used in continuous monitoring of wrist straps in an ESD protected area (EPA).

Resistive characterization is only one aspect to consider in evaluating garments for any specific application. To fully characterize a garment, electrical field attenuation, static decay, peak voltage, residual voltage and triboelectric charging may need to be considered. Other attributes related to applications and environments, such as cleanroom compatibility, chemical and fire resistance, should be evaluated in the garment selection process but are beyond the scope of this standard.

Garments constructed from fabrics made with fibres that are not surface conductive but may have other related properties that impart some level of electrostatic charge dissipation or suppression when connected to ground, are not specifically measured by the methods provided in this standard.

This being the case, some garment fabrics and construction may allow for surface voltage accumulation and charge transfer to occur which may be detrimental to electronic items.

ELECTROSTATICS –

Part 4-9: Standard test methods for specific applications – Garments

1 Scope

This part of IEC 61340 provides test methods for measuring the electrical resistance of garments used for static control applications. These test methods can be used for evaluating outer garments that are homogenously conductive or homogeneously dissipative, or that utilize surface conductive or surface dissipative components or elements.

NOTE The test methods defined in this standard may not be able to measure materials with buried conductive layers.

The resistance point-to-point test method tests the electrical resistance between the two sleeves, any two panels or any two or more electrically interconnected components of the static control garment, including the electrical resistance across the seams and cuffs of the garment as applicable.

An alternate sleeve-to-sleeve test method is allowed, using clamps to hang a garment.

Static control garments that electrically bond to the wearer and provide a path to ground from the wearer are evaluated using the resistance point-to-point test method, the resistance point to groundable point test method, as well as a system test to determine the resistance from the person through the garment to the groundable point of the garment system.

A band resistance measurement test is provided in IEC 61340-4-6 which can be used for garments so equipped with cuffs that are intended to perform the same function as a wrist strap band.

The system test with a person wearing a groundable static control garment system includes the ground cord that connects to the groundable point of the garment.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61340-2-3, *Electrostatics – Part 2-3: Methods of test for determining the resistance and resistivity of solid planar materials used to avoid electrostatic charge accumulation*

IEC 61340-4-6, *Electrostatics – Part 4-6: Standard test methods for specific applications – Wrist straps*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
acceptance testing
testing used to confirm to users that products delivered are substantially the same as the samples used to qualify products

3.2
garment system
any electrically interconnected components of static control apparel

3.3
point-to-point resistance
resistance measured from one point to another on the surface of the same panel or two different panels of a garment

Note 1 to entry: Point-to-point resistance is expressed in ohms.

3.4
static control garments
personnel garments that are designed for electrostatic charge control

3.5
product qualification
testing used to confirm that products comply with requirements of an ESD control program or other specification

3.6
groundable static control garment
garment that exhibits an electrical resistance from point-to-point and from any point or panel on the garment to the groundable point on the garment

Note 1 to entry: The groundable point may be a cuff contact to the wearer's skin or separate dedicated grounding point connector.

3.7
groundable static control garment system
garments that are used to establish the primary ground path for a person to the groundable point of the garment and the connection of the garment to ground, typically through a grounding cord

Note 1 to entry: The garment shall also meet all the requirements included in the definition for groundable static control garments.

4 Atmosphere for conditioning and testing

4.1 General

The following requirements supersede any other specification for the atmosphere for conditioning and testing that may be given in one or more of the documents referred to in this standard.

4.2 Low humidity

Unless otherwise agreed, the atmosphere for conditioning and testing for laboratory evaluations at low humidity shall be at a temperature of 23 °C ± 2 °C and 12 % ± 3 % relative humidity. The conditioning time prior to testing shall be at least 48 h.

4.3 Moderate humidity

The atmosphere for conditioning and testing for laboratory evaluations at moderate humidity shall be at a temperature of 23 °C ± 2 °C and 50 % ± 2 % relative humidity. The conditioning time prior to testing shall be at least 48 h.

5 Equipment and materials

5.1 Test equipment requirements

5.1.1 Resistance measurement apparatus

5.1.1.1 General

The measurement apparatus, called the meter, whether it is a single meter or collection of instruments, shall be capable of the following.

5.1.1.2 Product qualification

The meter shall have a circuit voltage while under load of 100 V (±5 %) for measurements of $1,0 \times 10^6$ Ω and above, and 10 V (±5 %) for measurements less than $1,0 \times 10^6$ Ω.

The meter shall be capable of making measurements from $1,0 \times 10^3$ Ω to $1,0 \times 10^{12}$ Ω.

5.1.1.3 Acceptance testing

The product qualification meter may be used for acceptance testing or the following:

The meter shall have an open circuit voltage of 100 V (±5 %) for measurements of $1,0 \times 10^6$ Ω and above, and 10 V (±5 %) for measurements less than $1,0 \times 10^6$ Ω.

The meter shall be capable of making measurements for $1,0 \times 10^3$ Ω to $1,0 \times 10^{12}$ Ω.

In case of disagreement the meter used for product qualification will be used to resolve any disputes.

5.1.1.4 Ohmmeter for testing personal ground path

Integrated checker or meter, whether it is a single meter (ohmmeter) or a collection of instruments that are capable of measuring from $5,0 \times 10^4$ Ω to at least $1,0 \times 10^8$ Ω with a test voltage from 7 V to 30 V DC open circuit.

Both test leads should be capable of being isolated from ground. AC line-powered resistance measuring devices may give erroneous results due to undefined ground paths. Battery powered equipment is recommended.

5.1.2 Resistance measurement electrodes

5.1.2.1 Cylindrical electrodes

A cylindrical 2,5 kg ± 0,25 kg rubber electrode with a diameter of 65 mm ± 0,5 mm, having a contact of electrically conductive material with a Shore-A (IRHD) durometer hardness between 50 and 70. The resistance between two electrodes should be less than $1,0 \times 10^3$ Ω when measured at 10 V on a metallic surface.

5.1.2.2 Clamps/electrodes

The clamps/electrodes shall consist of two flat electrically conductive plates (e.g. stainless steel) with a dimension of approximately 50 mm × 25 mm each. The clamp/electrodes shall be electrically conductive with sufficient compression force to retain and suspend the garment. See Figure 7.

5.1.2.3 Cuff test fixture

A test fixture comprising an insulative stand and two stainless steel cylinders approximately 25 mm in diameter, with one cylinder fixed to the stand directly above the second. The second cylinder will weigh approximately 0,11 kg and is mounted in a slot in the stand that allows free vertical movement. See Figure 10.

5.1.2.4 Hand-held electrode

A stainless steel, brass or copper round or tubular stock, approximately 25 mm in diameter and 75 mm or greater in length, with provision for connection to meter (such as a banana plug receptacle or screw connector) attached to one end of the cylinder. See Figure 11.

5.1.3 Support surface

5.1.3.1 Insulative support surface

An insulative surface when used for specimen support shall have a surface resistance of greater than $1,0 \times 10^{12}$ Ω when measured in accordance with IEC 61340-2-3. The insulative surface shall be large enough to accommodate the entire garment when it is laid out flat.

5.1.3.2 Insulative sleeve inserts

Two pieces of insulative material meeting the requirements of 5.1.3.1 cut into approximately 75 mm by 152 mm strips to slide into the sleeves (and cuffs if so equipped) of garments under test to isolate one side of the sleeve from the other.

5.1.3.3 Insulative hangers

The points to which the clamps described in 5.1.2.2 holding a garment under test shall be isolated from ground to a resistance greater than $1,0 \times 10^{12}$ Ω when measured with an instrument meeting the requirements of 5.1.1.3. Insulating thread may be used for this purpose.

6 Test procedure

6.1 Sample preparation

6.1.1 General

The test samples shall be processed through a minimum of five cycles of the garment manufacturer's prescribed or user defined cleaning process prior to performing laboratory tests.

6.1.2 Sample size

Test a minimum of three samples for each style and manufacturer for product qualification. For acceptance testing, the sample size shall be determined by the user.

6.1.3 Sample sketch

The person performing the tests should examine the garment's construction and make a general sketch showing separate front and back panels used to fabricate the garment.

Number the panels for measurement identification purposes from N° 1 to N° n. Identify the sleeves and cuffs as left and right. The groundable points, if they exist, should be shown on the sketch. The sketch should accompany the test results to become part of the test report.

6.2 Humidity requirements

For product qualification, resistance point-to-point, resistance point-to-groundable point and cuff measurements shall be conducted at two humidity conditions according to 4.2 and 4.3. Humidity conditioning for product qualification of the groundable static control garment system is optional and may require a walk-in environmental chamber.

NOTE Laboratory testing has shown that low and moderate humidity conditions do not have a consequential impact on the electrical resistance measurement of a garment in combination with a person.

6.3 Test procedures

6.3.1 General

Subclause 6.3 defines the test methods for measuring the electrical resistance of garments. It includes a resistance point-to-point test and a resistance point-to-groundable point test. The described test procedures may be used for product qualification and acceptance testing. A system test for a garment that provides a path to ground from a person while being worn is also described.

6.3.2 Resistance point-to-point

6.3.2.1 Panel-to-panel

Precondition the test samples according to 6.2 as required. Place the garment on an insulative support surface as described in 5.1.3.1. Place the garment with the front panels opened and laid out as flat as possible (larger garments such as overalls may not allow this completely). Place the insulative sleeve inserts from 5.1.3.2 into each sleeve (including the cuff, if so equipped, or leg cuffs of an overall) of the garment under test. Attach test leads from the resistance measuring apparatus (meter) to the electrodes defined in 5.1.2.1. Place one electrode on a panel of the sample. Place the second electrode on another panel of the same sample. Apply 10 V and observe the reading after 15 s. If the reading is less than $1{,}0 \times 10^6\ \Omega$, record the value. If the reading is greater than or equal to $1{,}0 \times 10^6\ \Omega$, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. Repeat for all electrically interconnected components and panels as well as cuff-to-cuff and sleeve-to-sleeve, making sure that the electrodes are directly above the insulative inserts (see Figure 1, Figure 2 and Figure 3). Repeat for all test samples.

6.3.2.2 Cuff-to-cuff

Some garments may have an insulative exterior and conductive interior of the cuff, or incorporate a wrist strap band or another wrist bonding mechanism or device. Precondition the test samples according to 6.2 as required. Insert the measurement electrodes inside the cuffs or wrist bonding devices. (See Figure 4 and Figure 5). Apply 10 V and observe the reading after 15 s. If the reading is less than $1{,}0 \times 10^6\ \Omega$, record the value. If the reading is greater than or equal to $1{,}0 \times 10^6\ \Omega$, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. Repeat for all test samples.

6.3.2.3 Hanging clamp sleeve-to-sleeve

Precondition the test samples according to 6.2 as required. Hang the garment from each sleeve with electrically isolated clamps (see Figure 6). Place the clamp so that it connects the exterior and the interior of the cuff. The resistance measurement shall be made by applying the voltage lead (positive) to one clamp and attaching the sensor lead (negative) to the other clamp. Apply 10 V and observe the reading after 15 s. If the reading is less than $1{,}0 \times 10^6\ \Omega$, record the value. If the reading is greater than or equal to $1{,}0 \times 10^6\ \Omega$, apply 100 V for a

minimum of 15 s (or until reading stabilizes) and record the results. Repeat for all test samples.

6.3.3 Resistance point-to-groundable point

Precondition the test samples according to 6.2 as required. Place the garment with the front panels opened and laid out as flat as possible (larger garments such as overalls may not allow this completely) on an insulative support surface as described in 5.1.3.1. Use one electrode described in 5.1.2.1 connected to the positive lead of the meter. Place the insulative sleeve insert from 5.1.3.2 into each sleeve of the garment under test. Place the electrode on a cuff (or inside as described in 6.3.2.2), sleeve (directly above the insulative insert) or panel. Connect the negative lead of the meter to the garment groundable point. Apply 10 V and observe the reading after 15 s. If the reading is less than $1{,}0 \times 10^6\ \Omega$, record the value. If the reading is greater than or equal to $1{,}0 \times 10^6\ \Omega$, apply 100 V for a minimum of 15 s (or until reading stabilizes) and record the results. If cuffs are designated as groundable points, measurements shall be made between sleeves and cuffs or between panels and cuffs; see 6.3.2.2 for cuff-to-cuff measurements. Repeat for all panels, sleeves and cuffs and groundable points (see Figure 8 and Figure 9). Repeat for all test samples.

6.3.4 Cuff measurements

IEC 61340-4-6 provides test methods for the evaluation of wrist strap bands and cuffs. These methods may be adapted for use in testing garment cuffs or any wrist strap cuff type grounding mechanism that may be part of a garment and used to bond to the skin of the wearer. The band resistance test procedure described in IEC 61340-4-6 may be used to measure the interior resistance of the garment cuff or wrist strap grounding mechanism (see Figure 10).

NOTE Some garments can be used in conjunction with resistance continuous monitoring systems. Garments of this type can have one cuff that provides the skin contact for personnel grounding, and the other cuff is used for monitoring the electrical continuity between the garment and the wearer. The two cuffs are isolated electrically from each other in this type of garment. The manufacturer can be contacted for assistance in measuring this type of garment.

6.3.5 Groundable static control garment system

This procedure verifies the resistance path from a person wearing the garment, through the body-garment cuff contacts or wrist strap cuff type grounding mechanism to the ground termination point of the garment grounding wire. Testing in a controlled environment is not a requirement of this subclause. Personnel shall wear the garment under test for a minimum of 10 min prior to testing.

This test is conducted with the meter described in 5.1.1.4. This test includes the ground cord and wearer's resistance as part of the total system resistance (see Figure 11 and Figure 12). The test can be performed using a proprietary integrated tester (Figure 12) or resistance meter of similar specification (Figure 11). Connect the grounding point of the garment to the tester using the ground cord. Contact is made to the tester via a push button (on the integrated tester, Figure 12) or a hand held electrode (Figure 11). Apply the test voltage and record the result.

Users of this standard should ensure that garments tested in this procedure meet the grounding requirements at the lowest humidity levels experienced in their facility.

7 Product qualification

Table 1 describes the test required, based on the garment that is being qualified.

Table 1 – Product qualification

Garment type	Qualification testing required
Static control garment	Point-to-point resistance (see 6.3.2)
Groundable static control garment	Point-to-point resistance Point-to-groundable point panel (if applicable) to groundable point (see 6.3.2 and 6.3.3)
Groundable static control garment system	Point to point resistance from panel to panel Point to groundable point panel to groundable point (see 6.3.2, 6.3.3 and integrated wrist strap in accordance with IEC 61340-4-6)

8 Reporting

Record all resistance values. Record the voltage levels, humidity and temperature for each test sample. Record the type of test equipment used and test date. See Annex B for an example of a data collection sheet with sketches.

Figure 1 – Test set-up – Resistance point-to-point (sleeve-to-sleeve procedure with insulative sleeve inserts)